Top 30 Bit Manipulation Techniques with Examples

1. Removing the Lowest Set Bit

Formula: n = n & (n - 1)

Example: For n = 10110100 (180), n & (n - 1) = 10110000 (176)

2. Isolating the Lowest Set Bit

Formula: n & (-n)

Example: For n = 10110100 (180), n & (-n) = 00000100 (4)

3. Checking if a Number is a Power of Two

Formula: (n & (n - 1)) == 0

Example: For n = 8 (1000), n & (n - 1) = 0000

4. Counting Set Bits (Hamming Weight)

Formula: while (n) { n = n & (n - 1); count++; }

Example: n = 10110100 has 4 set bits.

5. Swapping Two Numbers Without Temporary Variable

Formula: a = a ^ b; b = a ^ b; a = a ^ b;

Example: a = 5, b = 3 becomes a = 3, b = 5.

6. Reversing the Bits of a Number

Formula: rev = (rev << 1) | (n & 1); n >>= 1;

Example: n = 13 (00000000000000000000000000001101), rev = 2952790016

7. Setting the i-th Bit

Formula: n = n | (1 << i)

Example: n = 8 (1000), i = 1 results in n = 10 (1010)

8. Clearing the i-th Bit

Formula: n = n & ~(1 << i)

Example: n = 10 (1010), i = 1 results in n = 8 (1000)

9. Toggling the i-th Bit

Formula: n = n ^ (1 << i)

Example: n = 8 (1000), i = 2 results in n = 12 (1100)

10. Clearing MSB to i-th Bit

Formula: n = n & ((1 << i) - 1)

Example: n = 15 (1111), i = 2 results in n = 3 (0011)

11. Clearing i-th Bit to LSB

Formula: n = n & (~((1 << (i + 1)) - 1))

Example: n = 15 (1111), i = 1 results in n = 12 (1100)

12. Modulus Power of Two

Formula: n & ((1 << k) - 1)

Example: n = 77, k = 4, n % 16 = 13

13. Checking if a Bit is Set

Formula: (n & (1 << i)) != 0

Example: For n = 5 (101), i = 2 is set.

14. Inserting M into N at Position i to j

Formula: mask = ((1 << (j + 1)) - 1) ^ ((1 << i) - 1); N = N & ~mask; N = N | (M << i);

Example: N = 1024 (10000000000), M = 19 (10011), i = 2, j = 6

15. Flip All Bits

Formula: ~n

Example: n = 5 (101), ~n = -6

16. Multiply by Power of Two

Formula: n << k

Example: n = 5, k = 2 results in n = 20

17. Divide by Power of Two

Formula: n >> k

Example: n = 20, k = 2 results in n = 5

18. Checking if n is Odd or Even

Formula: n & 1

Example: n = 7 (111), result = 1 (Odd)

19. Turn Off Rightmost Set Bit

Formula: n = n & (n - 1)

Example: n = 10 (1010), becomes n = 8 (1000)

20. XOR from 1 to n

Formula: If n % 4 == 0 -> n; n % 4 == 1 -> 1; n % 4 == 2 -> n + 1; n % 4 == 3 -> 0

Example: XOR from 1 to 5 = 1

21. Parity of a Number

Formula: Use XOR over all bits.

Example: n = 1011 (odd parity)

22. Turn On Rightmost Zero

Formula: n = n | (n + 1)

Example: n = 1010, becomes n = 1011

23. Clear All Bits After i-th Bit

Formula: n = n & (-1 << (i + 1))

Example: n = 15 (1111), i = 2 becomes n = 8 (1000)

24. Toggle All Bits After i-th Bit

Formula: n = n ^ (-1 << (i + 1))

Example: n = 15 (1111), i = 2 becomes n = 7 (0111)

25. Sign Extend

Formula: n = n | (~((1 << i) - 1)) if bit i is set

Example: n = 5 (101), i = 2 remains the same.

26. Count Leading Zeros

Formula: __builtin_clz(n)

Example: n = 16 (10000), leading zeros = 27 (32-bit integer)

27. Count Trailing Zeros

Formula: __builtin_ctz(n)

Example: n = 16 (10000), trailing zeros = 4

28. Population Count (Count Set Bits)

Formula: __builtin_popcount(n)

Example: n = 15 (1111), set bits = 4

29. Log Base 2 of n

Formula: __builtin_clz(n)

Example: n = 8 (1000), log base 2 = 3

30. Extract Bits Between i and j

Formula: mask = ((1 << (j - i + 1)) - 1) << i; n = (n & mask) >> i

Example: n = 29 (11101), i = 1, j = 3 extracts 101 (5)